Literature Review

Innovation has a very wide connotation and therefore the literature review is very conscious not to digress from the research topic which hovers around all of the following viz.

(1) Manufacturing Industry
(2) Technical Innovation in product and or process
(3) Backdrop of impacting national policies

The keywords deployed are innovation, product, process, manufacturing, patent, breakthrough, technology et cetera, caution being to ensure the literature is technical, engineering and innovation oriented and not merely on economic or commercial or policy matters.

Fagerberg, Srholec and Verspagen (2009) seem to question an apparently obvious relation by asking whether innovation is important for development?

In the same breath, the authors seem to agree and ask next pertinent question - if so, how?

As per them, one of the popular perceptions of innovation, that one meets in print every day, is that has to do with developing brand new, advanced solutions for sophisticated, well-off customers, through exploitation of the breakthrough technologies. Such innovation is normally seen as carried out by highly educated resource in R&D intensive companies, being large or small, with strong ties to leading centres of excellence in the scientific world. Hence innovation in this sense is a classical “first world” phenomenon. There is, however, another way to look at innovation that goes significantly beyond the high-tech perception just carved. In this broader perspective, innovation – the attempt to try out new or improved products, processes or ways to do things – is a general aspect of most if not all economic activities. It includes new products and processes, as also improvements in areas such as supply-chain, that is, logistics, distribution and marketing.
The term may also be used for changes that are new to the local context, even if the contribution to the global knowledge bank is negligible. In this broader sense, it is argued, innovation may be as relevant in the developing part of the world as elsewhere.

The paper surveys the existing literature on the subject with a strong emphasis on recent evidence on the macro and – in particular - micro level.

As per authors, until this time, many would have considered it vague to consider innovation as an important issue for developing countries, and many probably still find it irrelevant. This perception or paradigm is based on the notion that innovation primarily is of interest for technology savvy firms in mature economic ambience. In accordance with this thinking, new technologies emerge in advanced economies and gradually percolate to the developing part of the globe. Since technology in this perspective is mature and debugged, such ingress may be expected to yield relatively quick benefits in the developing part of the world. To avoid this kind of free benefit, it is prophesied, legal instruments that prevent such allegedly costless diffusion are needed. Followers of this perspective therefore place great emphasis on intellectual property rights as incentive to secure steady technological progress in the advanced corners of the globe and thus in the global economy in totality. However, it is also acknowledged that such protection can never be perfect and will be short tenured in any case. Thus, diffusion of new technology, created through innovation in the advanced part of the world, should according to this perspective be expected to work as powerful equalizer in the global economy, making it possible for poor countries to quickly raise their standards of living. Sounds too much stretching and oversimplifying!!

Although the logic of this “public good” approach to the role of technology and innovation seemed convincing at first, it gradually and rightly emerged that it could not be the only aspect. Two pieces of evidence in particular came to undermine and unearth the approach. Firstly, it became obviously evident that the convergence in technology and productivity that the approach predicted did not realize on ground.
How could this happen?

Second, the most famous examples of countries that managed to escape the low development trap and raise their standards of living towards developed country levels relatively quickly were far from being passive adopters of new, developed countries technologies. On the contrary countries such as Korea (South), Taiwan and Singapore placed great emphasis on generating what later became known as “technological capabilities”, through a concerted effort by their own public and private sector actors and apparently it paid off handsomely.

It is natural to wonder as to why were such activist development strategies that contradicted much common beliefs, seemingly much more successful than the “hands off” approach advocated by leading authorities and institutions such as the IMF and the World Bank, what is often called the “Washington consensus”?

These were some of the questions that gradually became more central to the priorities of global leaders, strategists, experts and economists in the last few decades of the millennium and the beginning of the next and it led as we have shown to the emergence of new theories, approaches and evidence. Arguably, the process started already back in the 1950s when historians started analysing actual catching up processes and came up with generalizations that were far from the liberal “hands off” approach in favour among economists. As a consequence a plethora of studies emerged, mainly among economic historians and economists with a more unorthodox leaning, that focused on “capability building” of various sorts as indispensable for the processes of innovation development. This way of looking at things gained acceptance during the 1980s and 1990s as the success of the Asian tigers (and Japan before that) became more widely recognized and studied. The term “technological capability”, originally developed as a tool for analysing the Korean case, gradually became more widely used among researchers of development processes, and a large amount of analysis emerged using this approach to understand the performance of firms, industries and countries in the developing nations of the globe. It
is fair to say, however, that in spite of these developments, many economists continue to be unfazed by the “capability” approach, may be because it is seen as meso- or macro approach lacking proper micro foundations, theoretically as well empirically.

However, it is particularly at this point that these new developments, which follow similar efforts in the developed part of the world (particularly in Europe) from the 1990s onwards, has broadly pictured that the “high tech” approach to innovation which has framed much thinking and policy advice on the subject is squarely misleading when it comes to understanding the relationship between innovation and development.

In fact, the evidence on the other hand shows that innovation is quite widespread among developing country firms, and is associated with higher efficiency (e.g. development) and, as in the developed part of the globe, is dependent on network of interactions with other private and public players.

This is implies in qualitative terms innovation is found to be a powerful force of growth in both, the developed as well as the developing nations; and apropos, an issue that it is imperative to get a better understanding of, theoretically as well as empirically.

While this paper brought out an interesting fact, demystifying and negating general perception, the study is general fact and assessment based and not from core technical assessment.

Murat (2013), in his study investigated the relationship between innovation and economic growth theoretically and empirically. The period between years 1981-2008 is taken into account for nine European Countries. ADF (1981) and PP (1988) tests for testing the variables’ stationarity. The outcome of ADF and PP tests depicts that each series is not stationary on level in Austria, Denmark, Finland, France, Holland, Ireland, Spain and Italy. The results of standard Granger causality test illustrate that R&D expenditures drivegrowth in the GDP for Finland, France and Spain in direct
The results also indicate that GDP causes R&D expenditures in Denmark and there is no noticeable causality between variables in other countries. The findings support the innovation-oriented growth hypothesis for Finland, France and Spain.

However, there is bi-directional causality in Finland and France.

The results therefore unambiguously support the innovation based growth hypothesis for Austria, Finland and France. This paper, thus, while appears to explore direct connection between innovation and national growth, the methodology is R&D expenditure, GDP growth and other such indirect parameters.

This paper assumes innovation as a well understood term and makes no attempt to clarify the scope in and out.

**Cameron (1996)** opines that in the traditional theory of economic growth, productivity is steered by objective technological enhancement and productivity levels and growth rates should converge over a period of time. On the other hand, new theories of economic growth argue that the rate of innovation is the result of the profit-maximising choices of economic agents, and that it is, apropos, possible for there to be sustainable differences in productivity levels and growth rates. There has been a vast amount of research into the effect of innovation on productivity.

An agreement has evolved that, whether measured by R&D spending, patenting, or innovationcounts, innovation has an unignorable impact on productivity at the level of the firm, industry and country.

**Tourn and Cicekci (2007)** also picked a basic question “Is Innovation the engine for the economic growth?” and surveyed the empirical evidence on the connection between innovation and economic growth. They compared Turkey’s and other countries’
performances, and in the last part applied the econometric models on Turkey as well as several countries in order to make differential assessment.

There are three main conclusions.

The first is that innovation makes a significant contribution to growth. The second is that there are significant spill overs between countries, firms, and industries, and to a lesser extent from government-funded research. Third, that these spill overs tend to be localized, with foreign economies gaining significantly less from domestic innovation than other domestic firms.

Hanadi and Aruna (2013) are concerned as to how small and medium-sized enterprises (SMEs) develop new products. They believe that among firms of different sizes, SMEs are generally more flexible and change themselves according to scenario, thus are more organised to develop and implement new products and processes based on market need. The dearth of execution capabilities put significant limitation on SME development. Even though SMEs tend to draw motivated managers, they can hardly compete with larger firms. The dearth of leadership talent, noticeable in several countries in the region, has a cumulative impact on SMEs.

The flexibility of SMEs, their simple organizational structure, their low-risk and receptivity are the essential features facilitating them to be innovative (Harrison and Watson 1998). Therefore, SMEs across industries have the unrealized innovation potential (Chaminade and Vang 2006).

As per Leger and Swaminathan (2007), empirical evidence tends to indicate that the innovation process could track a different manner in developing countries. As per them, more research is needed on the connection between size of an organisation and innovation, IPRs and innovation, as well as on market structure and innovation, where the
theory and empirical evidence tend to be leading nowhere. Another challenge in empirical work consists in distinguishing between applied knowledge and gathered information, to find out more about their respective functions for innovation. But an important and necessary step is to substantiate the evidence in LDCs to further refine the theory on innovation, and connect with policy-making in this area. Knowing the relevance innovation could have for these countries’ development, it should be a priority.

**Danneels and Kleinschmidt (2001)** in the context of new product development argued that it consists of bringing together two main components: markets, that is demand, and technology, that is product and process. According to them, product innovation requires the firm to have competences relating to technology (enabling the firm to make the product) and relating to customers (enabling the firm to serve certain customers). These studies strongly indicate that neither merely internal competence of the firm nor merely customer requirements will drive a firm to undertake development. Innovation will emerge only when a technically competent organisation is able to figure out and respond to customer requirements by developing and/or improving products/processes.

**Martinez-Ros (1999)** appear to have done work closely in alignment with the thoughts of the research scholar since found that product and process innovations are interdependent and closely connected. Lumiste et al. (2004) found that Estonian SMEs were simultaneous in developing their products together with processes. However, Becheikh et al. (2006) based on a review of literature covering empirical studies on innovation in the manufacturing sector, found that researchers have fundamentally focused on product innovations more in SMEs, and therefore recommended that future development should focus on both product and process innovations.

China is a subject of significant interest w.r.t. its’ innovation performance and strategies. **Philipp and Philipp (2012)** studied as to what is the innovative performance of China’s
NIS in relative term, that is, international comparison. They derived results by drawing upon patent data into different value classes i.e., low, intermediate, and high performance of China’s NIS. Their results unearth the overall weak innovative performance of China’s NIS. In comparison to Germany and the United States, less than one percent of China’s patent applications are of intermediate or high value. China being hugely a successful economy, this figure suggests that China’s comparative advantage is in the creation of low-value innovations albeit increasingly in huge quantities.

**Zhang and Zheng (2011)** touched on a very different and pertinent aspect of innovation as they concluded in their study that educational institutes do not play their part in technological innovation. Further, the overall quality of product of colleges that is outgoing students is in decline. Second, the model results show that R & D investment, especially investment in basic research on the impact of technological innovation is very significant. Thirdly, researchers for the implementation of technological innovation also played a very significant role. There are more scientists and engineers in China than in any other developed countries, but it has not correspondingly produced scientific research of repute.

They go on to advise that as for insufficient technical innovation and brain drain phenomenon, investment in education must be increased, education and training institutions should be improved, and personnel training, must be strengthened to improve the overall quality of scientific and technical personnel. Sound human resources incentives should be established, to attract and retain high-tech personnel.

**Gu and Lundvall (2011)** have analysed the forces behind rapid growth in China and shown that prudent policies and learnings therefrom have been pivotal for the success. They pointed to challenges posed by the growth pattern and drawbacks in the innovation system. These
challenges and drawbacks are reflected in the new political signals giving priority to the concepts endogenous innovation and rhythmic development. Building upon the historical experience they argue that the best way to interpret these concepts is to see them as guided innovation driven economic growth and feedback based economic development.

The global reference and the legacy starting point is different than it was in 1985 but the basic perspective for reform with focus upon interaction between users and producers of knowledge and technology remains pertinent when designing the next significant change. Strengthening in-country demand and the capability of domestic users of technology is essence of success.

**Funke and Yu (2009)** study the impact of R&D on total factor productivity across Chinese states. They introduce innovations explicitly into a production function and evaluate their contribution to economic growth in the period of 1993 - 2006. The empirical results highlight the importance and the interaction between domestic and outside research. The evidence indicates that growth in China is not explained simply by factor input accumulation. If China is to sustain growth in the years ahead, it must become a more innovation-based economy. Firms need to introduce or improve products or production processes over time. They first to satisfy market needs and second to cope with increased competition from diffusion phenomena.

**Binder and Witt (2011)** set out to discuss whether innovations can also be said to raise well-being, and if so in which sense. They briefly reviewed several approaches that have been suggested in the literature just to find that the diagnosed lack of a measure is caused by the vexing difficulties that all of the approaches have with logical and time-dependent inconsistencies in how humans experience well-being. The question they have posed in the heading thus needs further research before an unambiguous answer can be expected, if it can be expected at all. What seems already clear, however, is that the widespread excitement about
technical progress, innovations, and economic growth in both economics and politics is not easy to justify in terms of how our wellbeing responds – however it is measured.

Tellis, Prabhu and Candy (2009) attempt a study of breakthrough innovation across nations. This study leads to inference that several aspects do not seem to be as important drivers of breakthrough innovation in firms across nations as many would imagine. Among these are some frequently believed metrics of national labour, capital, government regulation, and culture. On the other hand, internal corporate culture is an important driver of breakthrough innovation. The visible speedy progress of India and China presents some evidence of these factors in operation. In such an environment, national drivers are, more often than not, unlikely to be major discriminators of firms’ performance, at least in the seventeen countries studied. In addition, firm and national factors have different levels of sensitivity; this is because firm factors reflect the unique features of each firm, while national factors are common across all firms in the country.

A culturally innovative country such as the United States can be home to innovative firms, such as Apple or FedEx, and lumbering ones, such as Kodak and Kmart. Innovative firms such as Samsung (Korea) and Infosys (India) in traditionally lagging economies can leapfrog ahead of slumbering giants in historically advanced economies. Indeed, the corporate culture in some of these innovative firms develops precisely to overcome aspects of their home economies that would otherwise mar their innovating buds. Thus, national factors, such as government, culture, labour, and capital, are not ignorable. Rather, in the current environment among the seventeen economies in the sample, corporate culture seems to be more rooted than these traditional country drivers in predicting breakthrough innovation in firms across nations. Second, they find that breakthrough innovations translate into financial value to the firm. The importance of this finding lies in their measurement of breakthrough innovations with a survey but financial value with archival, publicly available data.
Frenken (2006) discusses three families of complexity models of technological innovation: (1) fitness landscape models, (2) network models, and (3) percolation models, as Frenken believes that complexity theory can be taken as an emerging paradigm for understanding the complex dynamics underlying processes of technology driven innovation. Complexity models have the advantage of capturing more realistic features of the innovation process, while pre-empting the danger of over-parameterisation.

Typically, complexity models start from a specification with only a solitary critical parameter (the $K$-parameter in NK-models, the $q$-parameter in percolation models or the $p$-parameter in network models).

A small number of parameters still allow one to understand a model’s behaviour well by simulation. Complexity modelling should thus not be misconstrued to be complicated models with many parameters and possible behaviours.

Naude, Szirmai and Goedhuys (2011) deal with and argue for understanding of the roles that entrepreneurs can adapt in innovation in even the world’s poorest nations. They focus specifically on the entrepreneurship–innovation nexus in the context of development and refer to the findings contained in the book Innovation, Entrepreneurship and Economic Development edited by Adam Szirmai, Wim Naudé and Micheline Goedhuys. They opine that Rapid economic catch-up depends on countries’ entrepreneurs being able to absorb and creatively adapt global technological knowledge. They highlight that Private indigenous-owned enterprises in East Asia explain the economic success of this region when compared with the foreign-dominated economies of Latin America.

Howitt (2013) points out that Canadians are three times richer with respect to 50 years ago thanks to new products and processes. The source of technological innovation is research and development (R&D), most of which takes place in the private sector of the
country. University research, however, and noticeably, is the main source of the basic building blocks of many of the core sectors of the economy, in everything from information technology to engineering and medicine to further. It is crucial for economic growth that the innovations that occur at Canadian universities get commercialized and ingress into the rest of economy. However, Canadian universities lag behind their US counterparts in generating technology transfer between academic research and organisations. With innovation and productivity at the forefront of the Canadian public policy agenda, it is crucial that governments create the right incentives for university researchers to pursue research that can eventually be profitably commercialized.

The overarching priority for Canada should be to attract the best researchers from the world. Though it may seem paradoxical, the evidence supports the view that the greatest benefit to society will come from scientists for whom practical utility and individual financial reward are insignificant considerations.

The best way to attract such scientists to Canada is to redirect research support towards the problems that are most challenging from an intellectual point of view.

Svensson (2008), in a study on “Growth Through Research And Development” find that the public sector in the OECD nations funds almost 30 per cent of all the R&D conducted in these nations. An issue for companies that conduct R&D is that the private return on R&D to the companies themselves is significantly lower than the overall social return. This difference is termed as spill over and in reality benefits other companies and society at large. Consequently, the actual amount of R&D conducted by companies on a free market falls below the socially optimal level. This is the core reason why the Government should fund R&D.

Knowledge is believed to be a product that is non-rivalry, which implies that several beneficiaries can use it at the same time. What is more, it only needs to be produced once. This explains why R&D and the knowledge it generates can lead to long-term growth.
One problem, however, is that knowledge is also no excludable, i.e. we can seldom prevent someone else from using it. (Spillovers are created). As a result, companies under-invest in R&D – even though the private return may be considerable. This in turn leads that institutions such as patent systems are required or that the Government has teeth to intervene; and funds R&D projects.

With regard to the return on R&D funded by the Government the literature gives, to say the least, mixed results. On an average, publicly-funded R&D has a positive return, but this is lower than the return on private R&D. This applies both to publicly-funded R&D that is performed by companies and R&D at universities and or research institutes. The few studies that divide State funded R&D into civil and defence-related R&D show, however, that defence-related R&D has no or even a negative effect on economic growth. The absence of positive effects from defence-related R&D may possibly be explained by the fact that it is the owner, which is the Government that usually owns the results of the research.

In the case of the technology transfer from the institutes to industry it is important that the universities/departments, and above all the researchers, have incentives to attempt commercialisation. The participation of the researchers is often required in the commercialisation process as they have what is termed non-documentable knowledge about the invention concerned that is needed when the time comes to work the invention/innovation to the needs of the market.

Ashford and Hall (2011) explore the non-trivial relationship between environmental regulation, innovation, and sustainable development within the context of an increasingly globalizing world, quite like vasudevkutumbkam. They address a crucial problem in achieving sustainability—lock-in or path dependency caused by the ignorance of firms to envision, design, and execute policies that would simultaneously achieve social, environmental, and economic goals.
They warn that the persons, firms, and governments who benefit from stay putting by merely maintaining the status quo or continuing its trends can possibly sink us deeper into unsustainability.

They create a major source of lock-in and path dependence—that gain from the present system and advancement of its current trends through the exercise of monopoly power, financial power and control, advertising, and regulatory and political capture, even though the citizens as a whole in a nation may not benefit.

Further, they block the way of potential leaders who may provide better pathways.

**Berentsen and Breu (2012)** point out that many countries parallely suffer from high inflation, low growth and poorly developed financial sectors. They integrated a microfounded model of money and finance into a model of endogenous growth in order to examine the effects of inflation on welfare, growth and the size of the financial sector. They believe that the innovation sector is decentralized. Financial intermediaries arise endogenously to provide liquidity to this sector. Consistent with the data but in contrast to previous work, reducing inflation generates large growth gains. These large gains cannot be easily reproduced by merely imposing a cash-in-advance constraint in the innovation arena.

**Singh (2006)** takes on the long-term innovation strategy of industrial and technological development in developing countries. As per him, the analysis of sources and indicators of innovations across countries and regions shows some fall in the concentration of innovations in the developed countries.

The foremost lesson which should be learnt from the East Asian experience to succeed in the global economy is to reinvent the role of Government to strengthen the national innovation institutional system. The developing countries are currently engaged in economic reforms to reduce the role of the Government and provide larger space to
market forces, which essentially make the Government scarce in economic activities. This strategy of making the Government scarce in developing countries suffers from the drawback of substitutability of the state or Government and the market and reduces the competitiveness of the domestic agents of production in the international economy.

Hautamaki (2010) focuses on Sustainable Innovation based on model of Finland. Finland’s economic success has been based primarily on their good innovation environment and well-functioning institutions. A clear unanimity regarding the lines of the innovation policy and among the basic actors has focused the common goals and heightened cooperation. The development of their innovation environment is continually at stake, and the then Finnish government strongly committed support for the financing of R&D activities.

Hautamaki believes that Globalization surely increases competition, but, perhaps more importantly, it opens up totally new opportunities for a progressive nation, particularly a small country like Finland. And, with strategic agility, Finland would be able to seize these opportunities. In order to succeed in this world of unexpected possibilities, one has to find its strengths. Finnish companies may or may not be able to compete with others in terms of price, but certainly, and it is no small deal, that they can when it comes to quality.

Oinas (2005) also studied Finland and believe that the Finnish economy has done exceedingly well in recent international comparisons of technological advancement and economic competitiveness. It has reached an enviable runner-upposition in just a couple of decades, measured by a range of indicators. The paper looks at the process of national scale competitiveness building in a historical perspective and discusses the factors contributing to the Finnish success.
It analyses and seeks befitting characterizations of the country-specific social capital that are believed to have provided the resource base for the competitiveness of the Finnish technology sector and the economy at large. Lastly, the paper addresses issues related to the sustainability of the system in light of contemporary understanding of what truly creates competitive advantage in the present-day world economy.

Dumi, Sinaj and Nuhiu (2012) looked at Intellectual Property Rights and the relation they have with economic growth w.r.t. Kosovo. It also reveals the instruments of Intellectual Property Rights and their impact on the developing and developed countries. At the end it analyses where Kosovo stands in regards to Intellectual Property rights and what are the steps that should be taken for the situation to improve.

The findings of this paper are some data, gathering in statistical analyse. This paper concludes that the infrastructure and technological advancement in this country is still weak, therefore major innovations and discoveries are unlikely to happen.

Gentzoglanis (2000) in his study on “Innovation and Growth in the Knowledge-based Economy” believes that if capital stock is considered in a broad sense, to include both physical and intellectual capital, the law of diminishing returns may not apply. He believes that the higher the investments in intangible assets the higher a country’s growth rate. The so-called AK growth models by taking into account both tangible and intangible capital do succeed in order to establish a positive relationship between growth rate and the capital stock. The empirical studies confirm this relationship. However, they fail to make an explicit account of the contribution of intangible capital to growth. This arises from the fact that lots of investments in intellectual capital and other intangible assets are not counted as such in national income and product accounts. The development of the AK models help to identify the neglected elements of
growth. They show the importance of taking them explicitly into account in order to better explain the current growth rates of the new economy.

Šakalytė and Bartuševičienė (2013), while studying the “Theoretical Aspects of Innovation Development” believe that the importance to comprehensively understand the conception of innovation, how innovation takes birth and performs within businesses emerges because of the strong linkage between innovation and economic welfare. Innovation is not only a factor of economic efficiency but also a driver of value creation in goods or services and promotion of company’s sustainability. Innovation is arguably defined as an economic stimulus, scientific and technological progress, social development and the condition of international competitiveness. However the understanding of innovation spans a wide range, therefore the systematic overview on the conception of innovation has been highlighted. The paper suggests principal theoretical approaches of innovation development.

As well this study examines the innovation value chain. The benefits of the innovation value chain divulges in demonstrating the most important interconnection in the overall innovation process from knowledge sourcing to the knowledge exploitation. This, as per the researcher, results in productivity and company’s growth.

Blackwell, Wilson, Street and Boulton (2009) in their paper “Radical innovation: crossing knowledge boundaries with interdisciplinary teams” believe that interdisciplinary innovation emerges from the positive effects. The positive effects result when stepping across the social boundaries that we structure knowledge by. Those boundaries include academic disciplines, government departments, companies’ internal functions, companies and sectors, as well as the boundaries between these domains. In the knowledge economy, it is often the case that the right knowledge to solve a problem and the problem itself are at two different places, so interdisciplinary innovation, another name for TRIZ, is an essential tool for the future.
There are also many problems today that need more than one kind of knowledge to solve them, so TRIZ or the interdisciplinary innovation is also an essential tool for the challenging problems of today.

**León-Ledesma (1999)** presents an extended model of cumulative growth in which the effects of innovation and catching-up are examined. The effect of innovation adds another source of cumulative growth to that of the traditional models and facilitates the consideration of the importance of non-price factors as determinants of international competitiveness.

The model permits analysing whether cumulative forces may lead to stable growth and whether this solution generates convergence or divergence in productivity levels. The structural model is then tested for a set of OECD nations over the period 1965 to 1994 and the results are used for carrying out the comparative dynamics analysis.

**Gecevska, Chiabert, Anisic, Lombardi and Cus (2010)** are concerned for innovation during the life of a product. Product Lifecycle Management (PLM) is the process of managing the whole life cycle of a product starting from generating an idea, conceptualization, business analyses, product design and solution architecture and technical implementation, verification and validation, to the successful entrance to the market, service, maintenance and product improvement.

At present, a wide range of stakeholders are demanding that companies ought to address product management through entire life cycle in a more comprehensive and sustainable way.

However, even if a company actually wishes to innovate its processes for improving the way to account for project management, it will face pertinent challenges to deal with different guidelines.
Bescherer (2010) is aptly concerned about cost, inseparable from innovation. His study set out to identify, classify and describe how new product development ideas are analysed with cost information gathered in pre-development. The focus of this research is the circumstances of development preparation of cost-competitive products through future product cost analysis during pre-development phases. This work contributes to the answers in several directions of research requested by other academics.


Kaur (2014) raised the bar further by bringing in target costing as the true innovation challenge. Her paper explains that target costing method can be easily implemented for simple as well as for complex type products of any manufacturing firm. Further, her paper presents the general process of target costing and three levels of target costing as its specific process of application and the paper reports that the general process is suitable for simple products while the specific process or three levels of target costing is suitable for complex type products.

Since most literature covered above claims study on innovation related aspects without actually studying any technology in specific, a paper by Giedraitis and Rajanbabu (2011) is reviewed, which also concerns a study related to Innovation and Development
in India, specifically with respect to biotechnology sector, in comparison to Lithuania, a former soviet bloc nation bordering Poland, Latvia and Belarus.

The authors believe that in both countries, the biotechnology sectors are major drivers of nation’s economic growth. In the case of Lithuania, the country learns from Schumpeter’s ideas of innovation and Porter’s business cluster theory, and thus put forth that Lithuania is “at the right place and the right time” to make it a regional leader in Baltic biotechnology. Though significantly different, India’s biotechnology sector is also swiftly changing and advancing in innovation.

Particularly with regards to India, the paper states that the Govt. of India has been ploughing in Biotechnology Parks in order to encourage the Research and development effectively, in a manner similar to Lithuania. The biotechnology parks develop the skilled manpower and resources. The paper cites many Biotech parks dotted over the country, one of them being Golden Jubilee Biotechnology park for women, Chennai, Tamilnadu - This Biotech Park was developed under the joint project of the department of biotechnology and Government of Tamilnadu. The park is involved in the manufacturing of herbal cosmetics, bio-fertilizers, bio-pesticides, essential oil and spice fortified with herbs. In other words, Indian Biotech muscle is getting visibility in the world’s Biotechnology cluster. More investments, schemes and lots of multinational companies and domestic companies are also playing the important role in shaping the biotech industry of India.

The author claims to have shown, in their paper the different ways in which the biotechnology sectors have been developing in Lithuania as well as in India. The main findings based on their relative historical approach are: Biotechnology is already contributing greatly to India’s economy. Nation wise, in the case of Lithuania, biotechnology is rapidly growing, and is seen as a future leading edge segment. Thus, biotechnology is contributing to economies of both countries at an accelerating rate. There is a concern, though, that the current investors may be increasingly diversifying their investment to other nations, causing the rate of investment and development in
Lithuania to decelerate. Moreover, with the increasing cost of labour in Lithuania, foreign investors may find it more profitable to invest in nations with less expensive labour.

Low costs are, though, not the only explanation for diversification. Companies may also seek technological success by using local, qualified talent pool. Both Lithuania and India are seen to have been benefitted greatly from government investment in the biotechnology sector. In both cases, the authors find that the strength of business clusters greatly benefitted to formation of the biotechnology sectors. Lithuania is additionally benefitted from the “inherited” domain from the background of the USSR, and the resulting economical, qualified labour resource.

This paper, yet again, peripherally assesses the technology by investments and policies rather than absolute results!

The most pertinent literature found closest to the subject of research is The Innovation Index released by INSEAD business school every year, where Confederation of Indian Industries (CII) is involved as well. It is a very exhaustive annual document and now also widely recognized and accepted.

The innovation index for India for the last four years is as follows:

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<th>Year</th>
<th>Index</th>
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<td>2011</td>
<td>62</td>
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<td>2012</td>
<td>64</td>
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<td>2013</td>
<td>66</td>
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<td>2014</td>
<td>76</td>
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As can be seen by the flow diagram given below, the Innovation Index is given here is a ratio of several creative and technological outputs with respect to several infrastructural and environmental inputs. This index is more of an efficiency or effectivity of investments and policies rather than core innovation as such.
In virtually all the available literature, the researchers have given deep insight of investment, policies and methodologies at macro level with respect to innovation and technical developments. It appears that most countries which chose to liberalize their economy did become more innovative than earlier. However, the evidences are more strategic and economic than technical.

While all studied literature claims to relate to innovation directly, there is hardly any study which looks at the industrial innovation in gross and in true engineering manner, probably because it is not easy to identify which route of research cuts across most industries.

There can be a question whether the literature review missing the point?

Not at all.
It is not that study of patents is not recognized as an established process of ascertaining innovation. Study of patents is a common way of any business establishing several facts strategic to one’s business. The most common objectives of patent study are:

1. State of the art analysis
2. Free to operate search
3. Prior Art search
4. Portfolio mapping

Each of this study is business and subject specific and therefore has limited aspect and relevance only to select few.

Let us dwelve in it a bit:

State of the Art analysis – To be ahead in any industrial arena, one constantly assesses where one stands with respect to others. Such a study is important for the business houses to strategize their development and investment plans.

Let us understand this aspect by way of an example.

An entrepreneur, dummy named as Mr. A wishes to start a business of luggage bags in India. Mr. A gathers information about luggage cases by visiting exhibitions, show rooms and websites of renowned manufacturers.

Mr. A starts his business by picking up some of the popular designs.

However, soon he finds new models launched by the competitors. Not only that, Mr. finds several new global brands in India, which were not found few months back when he did market.
Mr. A then consults an industry expert and learns that he needs to conduct a state of the art analysis, by which all the published patent applications should be studied for novelty and inventiveness.

Following are illustrative images out of an elaborate study of more than 100 pages.

The first image\(^1\) above discloses a suitcase which is capable of following the owner based on sensors embedded in the shoes. The manoeuvring, that is – start, stop, turn, deactivate is by way of radio commands generated from the mobile phone based on user interface application.

The second image\(^2\) below is quite self-explanatory!

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\(^1\) Image taken from the patent application in public domain, application number mentioned in the box.
\(^2\) Image taken from the patent application in public domain, application number mentioned in the box.
The innovation essentially is joining two luggage cases by way of a zipper. Such a simple innovation makes it quite convenient for a passenger to carry two suitcases while manoeuvring only one!

While the previous innovation needed huge investment, the innovation above is implementable in days. Also, marketability and affordability of general customers is relatively far higher. Technologically, the second innovation is robust and not need elaborate validation.

Let us look at two more examples in order to fully understand the utility of study of such documents:
The third image\(^3\) above exhibits a smart innovation where a luggage case becomes a mini table for the passenger.

Regular travellers know well they need to be stay putting at crowded places with no place to keep their other goods while taking a quick bite. Such a value addition of a luggage case possibly comes with not much extra cost, of course, other than depending on price positioning.

Anyone buying a travelling bag would opt for above bag if such an option was available while making selection!

\(^3\) Image taken from the patent application in public domain, application number mentioned in the box.
The fourth and last example included here is probably the simplest innovation, properly built in the product prudently.

The image\(^4\) below reminds all travellers of trying to entangle their bags with one another so that they could all be pulled together...and this innovation does just that by providing a strap on another bag!

<table>
<thead>
<tr>
<th>Applicant: Jeffrey Herold</th>
</tr>
</thead>
<tbody>
<tr>
<td>In Public Domain Since: Jan 20, 2015</td>
</tr>
<tr>
<td>Title: Self-stabilized Rollable Luggage Assembly and Corresponding Assembly Method</td>
</tr>
<tr>
<td>Publication No: US8936140 B2</td>
</tr>
</tbody>
</table>

- Attachment for second luggage to join it with first luggage.
- Traveller can carry more suitcases with easier maneuverability
- Traveller becomes free to hold mobile phone or other conveniences

Once again, here, the cost of extra feature is miniscule and customer would make selection in favour of products with such a cute feature at no additional burden, in literary as well as monetary context.......
Inference related to state of the art study

By such a report of which a trailer is given hereinabove, Mr. A knows sufficiently in advance about the latest innovation and manufactures, even if the products are yet to hit the market.

One needs to remember that a patent application is published generally after 18 months of filing and this is an internationally accepted statute, unless there is express request by the inventor(s) and or applicant to disclose earlier, for a prescribed fee.

This period of 18 months is arrived at based on engineering data that once an idea is conceptualized with enough information so as to file a patent, the product takes about two years to take shape and thus a patent document should not disclose classified information of an organisation, earlier than the product itself.

In reality, however, products take longer and hence it makes sense to keep an eye on patents to predict arrival of new products.

This also implies that the innovations lined up for protection are NOT known to the world at large for this period of about two years and this is the reason every inventor rushes to secure an early filing date, in order to secure priority.

We shall build understanding of other three kinds of studies from the above examples
Freedom to operate

Having learnt about above innovations, Mr. A CANNOT simply use the idea and manufacture or market the product. Mr. A needs to ascertain in which all countries is the patent document filed and what is the remaining life of the patent. A slip on either account might put Mr. A into infringement case and cost him dearly.

Even if Mr. A had got such an idea all by himself, and even if he got such an idea earlier than such filed patents, he could still be held liable since the patent laws work on “first to file” and not “first to invent” system.

In simpler words, an entrepreneur is NOT free to manufacturer anything and everything available around or apparently thought, apparently before others – unless one has ascertained with surety that the idea, whether a product or process is NOT owned by someone else.

It is generally felt that few countries DO NOT respect intellectual property of others and this page is included to build a connection between such discrete pieces of knowledge.

We move on to discuss another kind of literature – Prior Art.
Prior Art Study

Building on the same illustration, while developing products for his business, the team of Mr. A hits upon an idea to make an animal shaped luggage case.

Since, it appears to be quite innovative, Mr. A wonders if something could be done to prevent others from imitating his idea.

Mr. A shall need to ascertain that there is no patent nor any published literature describing such a product. This requirement comes from the statutory requirement that a patentable matter ought to be

(a) New,
(b) Inventive, and
(c) Industrially applicable.

\(^5\text{Image taken for illustration from the patent application US20150034520A1, in public domain.}\)
New Invention is defined in the Section 2 (l) of the Patent Act, 1970, amendment 2005 as follows:

“New Invention” means any invention or technology which has not been anticipated by publication in any document or used in the country or elsewhere in the world before the date of filing of patent application with complete specification, i.e. the subject matter has not fallen in public domain or that does not form part of the state of the art.

Section 2 (j) defines “inventive” as follows:

“Invention” means a new product or process involving an inventive step nd capable of industrial application.

Section 2(ja) in turr defines “ Inventive step” as follows:

“Inventive Step” means a feature of an invention that involves technical advance as compared to the existing knowledge or having economic significance or both and that makes the invention not obvious to a person skilled in the art.

The above discussion is stretched in order to get sufficient clarity that unless a proper prior art search is undertaken; the steps to secure shall be in vein.

Further, as example, if another luggage design exists in the shape of any other four legged animal, then design of Mr. A may not qualify as inventive.

Let us look at last version before inferencing.
Portfolio Mapping

Mapping IP of an organisation, whether active or inactive in order to assess the monetary valuation of IP, judgement of innovation culture and potential for future growth are some of the objectives of portfolio mapping.

Such mapping includes patents, published papers, internal processes, classified information, product drawings, process sheets et cetera.

Then why not provide reviews of such Published Literature?

The entire illustration around patent analyses built above is a hypothetical case, developed to elaborate the power and intensity of such literature. Such literature, however, are NOT in public domain since they are classified information of organisations on which rests their business strategy.

The researcher has previously conducted several such studies, albeit on a much tinier level, a snapshot of one such actual studies is now given below as evidence.

Such reports are obviously not published in public domain and illustration is being given here in sampling manner, after concealing the classified part therefrom.
State of the Art in Electronic Jewellery

The subject itself is mind boggling – Electronic Jewellery !!!

A simple search reveals following: Following no. of patent hits are obtained in global databases, on searching and first level refining for patents related to “Electronics on Wearable fashion”, where the search is done with multiple strings, the most significant being:

<table>
<thead>
<tr>
<th>String</th>
<th>No. of Patents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jewellery &amp; Communication</td>
<td>295</td>
</tr>
<tr>
<td>Jewellery &amp; Electrics, Light</td>
<td>110</td>
</tr>
<tr>
<td>Wearing Apparels with Electronic Jewellery</td>
<td>40</td>
</tr>
</tbody>
</table>

The established jewellery manufacturers, who supply to developed nations, and who travel around the globe several times in a year initially disbelieved that there could be onslaught of electronics, till such a study was undertaken.

A number of them are re-strategizing their company plans after going through this report, which is made by the research scholar. Only illustrative part is being included here in accordance with the business ethics.

It is no wonder that to accelerate the development of wearable products, Intel, the well-known global ASIC manufacturer unveiled Curie module, a jewellery specific microchip, along with a complete software solution that includes a small and efficient real-time operating system (RTOS) together with reference wearable applications called Intel® IQ Software Kits. The kits include the embedded software that runs on the module
together with companion smartphone applications and associated cloud capabilities. The chip is likely to be commercially available in next three months, that is, by July, 2015!

An illustrative tabulation of a few eye turning electronic jewellery on next page cannot go unnoticed by the assessor of this thesis, which is in reality on a subject of real time!
<table>
<thead>
<tr>
<th>Patent Number</th>
<th>Filing Date</th>
<th>Novelty</th>
<th>Drawing</th>
</tr>
</thead>
<tbody>
<tr>
<td>DE102004063871A1</td>
<td>30-Dec-04</td>
<td>The necklace is assembled of several rings of different diameters. Each of the rings is fitted with an electronically operated miniature device such as a mobile phone, a camera, an MP3-player, a pager, an emergency transmitter.</td>
<td><img src="image1.png" alt="Drawing" /></td>
</tr>
<tr>
<td>EP 2368455 A1</td>
<td>18-Mar-10</td>
<td>A body wearable chain of a number of decorative links, electronic display-links are designed as self-luminous display can show a picture or a video</td>
<td><img src="image2.png" alt="Drawing" /></td>
</tr>
<tr>
<td>US20050113081</td>
<td>24-Nov-03</td>
<td>A fashion accessory provides a visual alert for the presence of a mobile communication signal from a nearby but not physically connected communication device. Defined distance is selected so as to make the fashion accessory responsive only to signals from a mobile device within a user's personal space.</td>
<td><img src="image3.png" alt="Drawing" /></td>
</tr>
<tr>
<td>US 6845063 B2</td>
<td>18-Jan-01</td>
<td>Audible medical emergency system for a patient comprising a bracelet which is battery operated and is worn on patient.</td>
<td><img src="image4.png" alt="Drawing" /></td>
</tr>
<tr>
<td>CN 202750215 U</td>
<td>10-Aug-12</td>
<td>The earring-type headphones having design is unique, the ear hangs and the eardrops are arranged on existing Bluetooth headphones, thus making the ordinary Bluetooth headphones attractive, fashionable and with practicality.</td>
<td><img src="image5.png" alt="Drawing" /></td>
</tr>
<tr>
<td>CN 201523441 U</td>
<td>06-May-09</td>
<td>Earring-type bluetooth headset a ring hole (8) connected with the earring chain (1) is arranged on a bluetooth headset shell (5), and an earphone</td>
<td><img src="image6.png" alt="Drawing" /></td>
</tr>
<tr>
<td>CN 201957214 U</td>
<td>31-Dec-10</td>
<td>A necklace type sound reproduction apparatus detachable</td>
<td><img src="image7.png" alt="Drawing" /></td>
</tr>
</tbody>
</table>
The point to note is that while there is apparently no published literature on core technological aspects assessments of any country, such studies are taken up at discrete level, with huge expertise and clear objective.

The researcher has undertaken to take up this research on national level.